CERES Aqua Beta1 SSF Cloud Properties - Accuracy and Validation

This section discusses the spectral radiances and cloud products included in the **SSF** data set version *Aqua* MODIS **Beta1**. Additional information is in the Description/Abstract Guide. The cloud products in the SSF are the result of convolving the values for the clear-sky and cloudy data derived for each 1-km MODIS pixel sampled every other pixel and scan line (see Convolution Process) to give an effective resolution of 2 km that matches that of VIRS. Five radiances taken at 0.65 (visible, VIS), 2.13 (near infrared, NIR), 3.75 (solar infrared, SIR), 11.0 (infrared, IR), and 12.0 (split-window channel, SWC) μm, channels 1, 7, 20, 31, and 32, respectively, are used for each MODIS pixel.

Cloud Mask

Based on the values of these radiances, each MODIS pixel is classified as clear, cloudy, bad data, or no retrieval. Each clear pixel is categorized as weak, strong, snow, aerosol, smoke, fire, glint, or shadow. Cloudy pixels are categorized as weak, strong, or glint, where glint means that pixel was detected at an angle favorable for the viewing of specular reflection. Weak or strong categorizations indicate the degree of confidence in the selection. Atmospheric profiles of temperature, ozone, and humidity, model estimates of surface skin temperature (see MOA description), elevation, and one of the nineteen surface types (CERES Surface Properties Home Page) are also associated with each MODIS pixel. Because of problems with Aqua MODIS channel 6 (1.64 μm), channel 7 (2.13 μm) is now being used in place of channel 6 in the masks. This substitution is especially critical for the ice/snow detection. Accordingly, clear-snow albedo models have been developed for 2.13 μm to ensure reliable snow detection during daytime. The behavior of the snow reflectance at 2.13 μm for Aqua MODIS cloud detection is modeled using the ratio of the *Terra* channel-7 and channel-6 reflectances (Fig. 1) along with the 1.6-μm models used for the *Terra* MODIS analyses.

The cloud masks rely on comparisons of the observed radiances to estimates of the radiances for a cloud-free scene at a given pixel location and viewing and illumination conditions. These estimates are based on empirically derived maps of clear-sky overhead-sun spectral albedo, models of the solar-zenith angle (SZA) dependence of albedo, and surface emissivities that use the MOA input. Other than the substitution of channel 7 for channel 6, the clear-sky reflectance predictions and the mask algorithms used for *Aqua* MODIS **Beta1** processing are identical to those used for the *Terra* MODIS **Edition1A** processing. An example of the polar mask using the 2.13-μm reflectances is shown in Fig. 2.

Bad-data pixels are those having at least one radiance that was set to a default value or was outside of the allowed range. The greatest problem causing bad data was the saturation of the thermal channels over land. The saturation temperatures for the *Terra* MODIS channels 20, 31, and 32 are 330 K. Because of its reflected solar component, the 3.7-μm channel is occasionally saturated during daytime over deserts and in some extreme sunglint cases over ocean. No-retrieval pixels are those that are initially identified as cloudy, but their radiances cannot be interpreted with the theoretical models used to derive cloud microphysical properties. Further description and discussion of the cloud mask and data problems can be found in the Terra Edition1A Data Quality Summary.

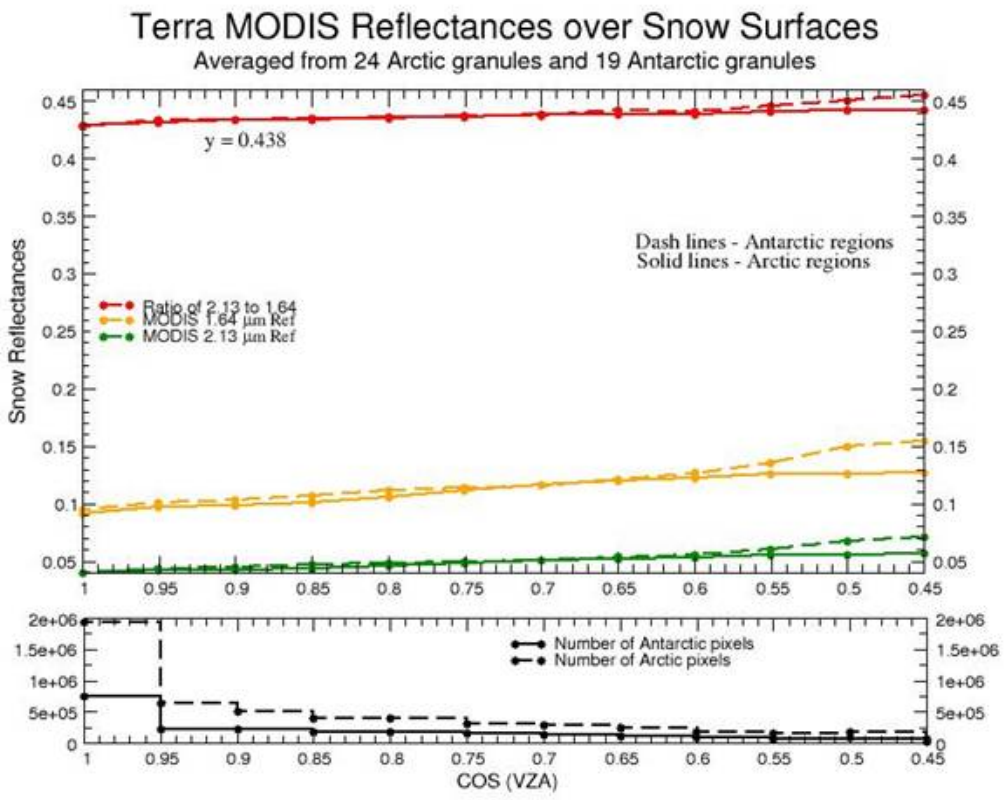

Fig. 1. Development of ratios to apply to *Aqua* 2.13-μm data to account for the lack of reliable 1.6-μm data.

Cloud Property Retrievals

The following values are computed for each cloudy pixel: phase (ice or water), VIS optical depth τ, IR emissivity, liquid or ice water path *WP*, effective droplet radius r_e or effective ice crystal diameter D_e, cloud-top pressure, effective cloud height z_c and temperature T_c, and cloud-base and top pressures, p_b and p_t, respectively. Normally, the cloud phase, temperature, effective particle size and optical depth are computed using the VIS-IR-NIR-SWC Technique (VISST). The VIS channel is primarily used to estimate τ; the IR channel is for T_c, and the SIR channel is used for the particle size (Minnis et al. 1995), and the SWC is used to help the phase selection. Cloud height and pressure are found by matching T_c to an altitude in MOA vertical profile of temperature for the pixel location and time. The VISST used for *Aqua* MODIS **Beta1** is the same as that for *Terra* MODIS **Edition1A**. If the underlying surface is determined to be snow- or ice-covered either from the snow-ice maps or from identification of nearby pixels as clear snow, then the SIR-IR-NIR Technique (SINT) is applied. This technique used 1.6-μm as the NIR channel for **Edition1A** to compute optical depth. For the *Aqua* **Beta1**, the 2.13 μm data replace the 1.6-μm data. Reflectance lookup tables were computed at 2.13 μm in the same manner used for the other channels in previous editions.

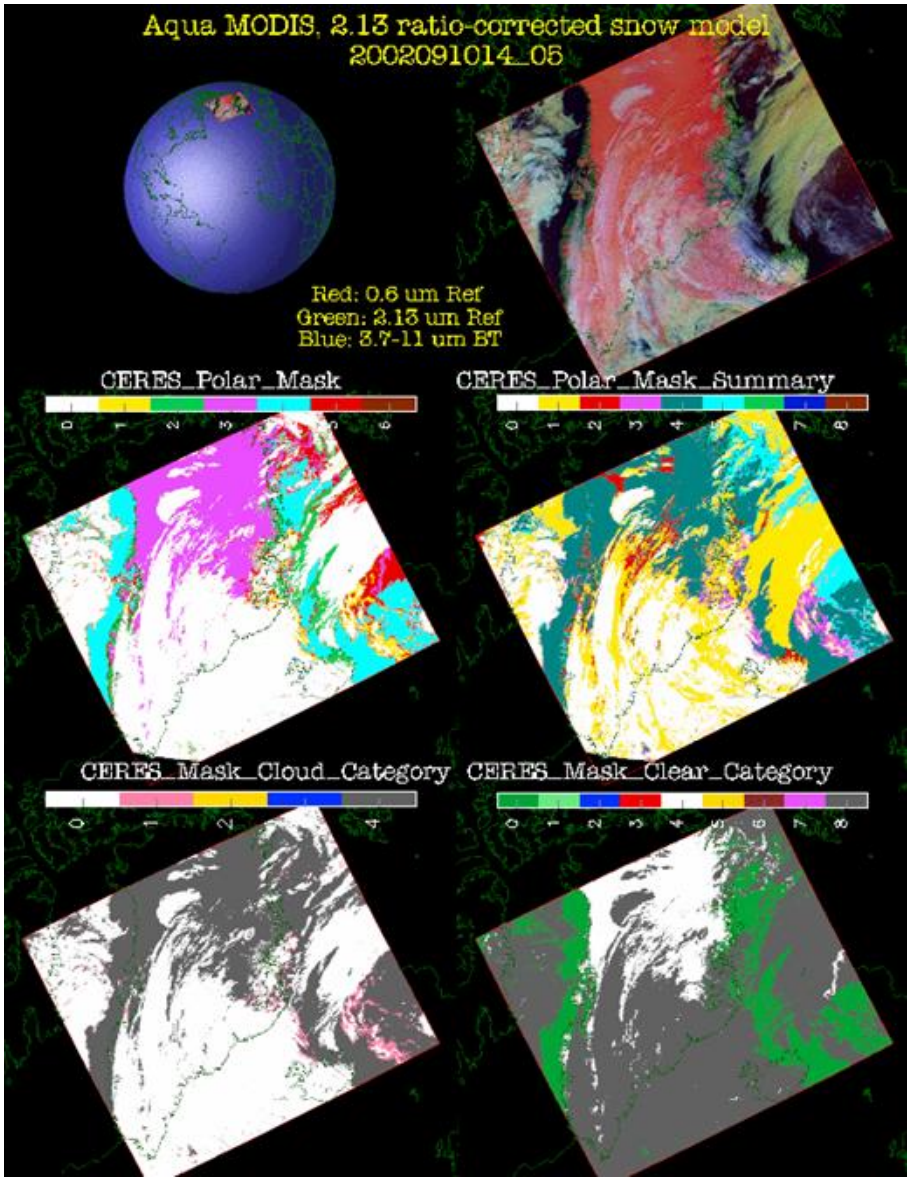

Fig. 2. CERES daytime polar mask applied to Aqua MODIS data using 2.13-μm reflectance for primary snow determination, 10 September 2002, 1400 UTC.

An example of the VISST retrievals for *Aqua* **Beta1** is given in Fig. 3. The results appear to be reasonable and initial comparisons with radar data taken over the Oklahoma ARM site show excellent agreement in terms of height, optical depth, and particle size for cirrus clouds. The quality of the retrievals should be on a par with those from *Terra* MODIS **Edition1A**. However, calibration of the Aqua channels has not yet been examined and validation of the *Aqua* retrievals has just begun, so the results must be treated with much caution. For additional discussion, please refer to the Terra Edition1A SSF Data Quality Summary.

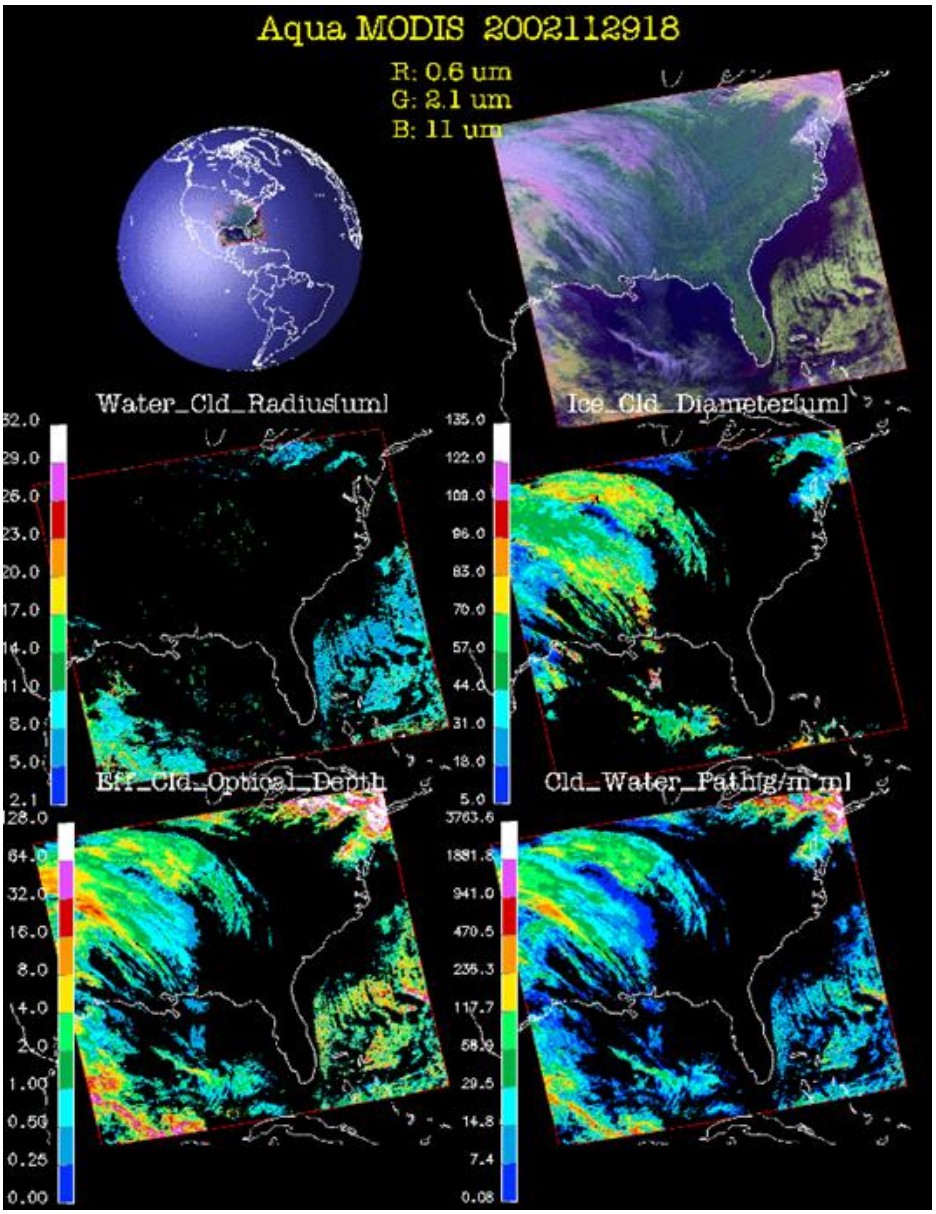

Fig. 3. Cloud microphysical properties derived with VISST from Aqua MODIS Beta1 algorithm, 29 November 2002, 1800 UTC.

Return to Quality Summary for: Aqua Beta1 SSF